

Integration of E-learning Elements with Engineering Education

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Abstract - The paper aims to describe the process of how to improve the quality of engineering education based on the introduction of elements (which have been already tested within previous projects): textbooks focused on part time study, completed with objectives for each chapter, worked out examples originated as theory and/or from practical experience, questions and tasks for self-learning. This requires video-sequences creation (prepared as real time views, laboratory measurements and similar areas, or life lecture recording, which is especially wanted by the students). Static text descriptions complete the computer animations with dynamic and repeated views of described events. Interactive programs enable students with modeling theoretical and real time processes, when input parameters are being changed individually and then monitoring the result changes.

Index Terms – e-learning system, Modular Object-Oriented Dynamic Learning Environment, engineering education.

INTRODUCTION TO THE CONTROL SYSTEM FUNDAMENTALS COURSE

The Department of Control Systems and Instrumentation guarantees teaching the subject of Control Systems Fundamentals. This subject is taught for all students of the second year study at the Mechanical Engineering Faculty. The teaching involves about 345 students of the full time and 300 students of the part time study programs, but what is more important, about half of the students are taught at our University detached training centers, so the teachers travel to these scheduled courses.

The subject curriculum consists of:

- Logical functions, logical control system design and implementation.
- Analysis and synthesis of continuous control systems, with mathematical modeling, controllers design, system stability and controllers tuning, quality control methods for designed systems.

Part of the teaching takes place in laboratories with prepared models, for both the logical and continuous control:

- Implementations of simple logic functions in alpha microcontrollers are prepared. Two tasks show the logic control of tanks and their visualization. Other two tasks show GSM controller application with simple security and heating model functions.

- For the measurement, identification, modeling, controllers tuning implemented in the continuous control area an existing model of hot air aggregate is used in already pre-programmed, specialized simulation environments, such as SIPRO and Matlab/Simulink. Temperature control and multi-dimensional control are available.
 - For continuous control tasks of the tank level with the help of a digital controller, close-loop control with PID digital KS98+ controller is configured.
 - Four simple tasks to control air flow or temperature are set as identification and control experiments to manage continuous and discontinuous controller parameters.
 - New modules from Matlab are used to describe basic characteristics and test controller tuning by Ziegler-Nichols techniques.
 - Technical means, such as sensors, transducers and AD/DA converters, are used in laboratory models to explain their basic functionalities and applications.
- The theoretical lessons also include simulation software, visualization programs to introduce the basic functions of supervisory control, such as alarms, trends, system security, and others.

E-LEARNING SYSTEMS AND THEIR ELEMENTS

The market offers several e-learning systems, such as WebCT, BlackBoard, LearningSpace. Some e-learning systems are available as shareware such as Moodle, ClassWeb, OpenCourse. The main reasons to use e-learning systems are:

- Decreasing cost for classical education (teaching staff and consulting hours).
- Easy and fast access to information directly in the classroom.
- Time independence and the possibility for an individual study pace.

On the other hand, e-learning systems demand hardware and accompanying computer tools.

Modular Object-Oriented Dynamic Learning Environment (Moodle) was started by Martin Dougiamas and has been evolving since 1999 (since 2001 with the current architecture). VSB -Technical University has decided to select this environment (see Figure 1) as the environment for creating learning modules across the university, mainly because it has many features expected from an e-learning platform including:

- Works with PHP, MySQL and CSS.

- Does not require a specialized web page browser.

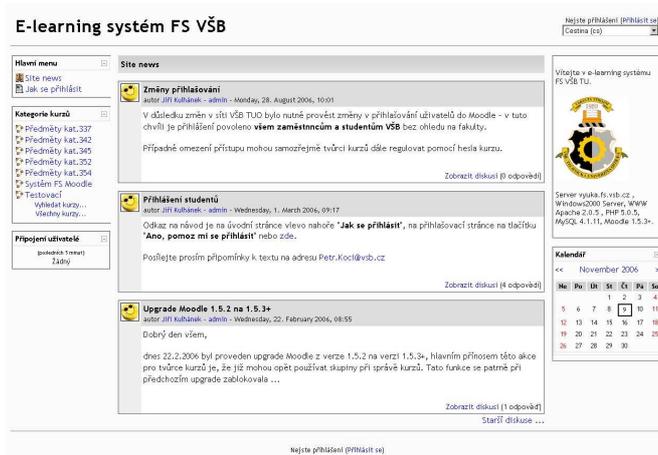


FIGURE 1
THE E-LEARNING SITE FOR MECHANICAL ENGINEERING
[HTTP://VYUKA.FS.VSB.CZ](http://vyuka.fs.vsb.cz)

The elements of e-learning platform:

- Surveys - allow a teacher to ask a question and offer a few options for answering. A student selects one question. Then the teacher based on a selected answer decides which way the course will go.
- Lessons – teaching material prepared by a teacher, who defines control questions for each chapter.
- Tasks – as an arbitrary instruction for students (for example to study materials, to decide a solution), or to ask a student to send a file created to a teacher for evaluation (for example a drawn diagram, source code, written project.). An alternative can be a task mutually evaluated by students.
- Tests – when teachers maintain a database of testing questions saved in different categories in order to generate an on-line test. Questions can have more than one correct answer and pictures may be a part of them.
- Workshops – for which the students work out a task and evaluate it as brainstorming. The teacher evaluates not only the quality of the work but the evaluations as well. Workshop offers a wide range of tools.
- Forum – publishes work of course participants, which can be searched through and displayed with different points of view and evaluated. A part of each forum is a section for News serving a role as a notice board with up-to-date information.
- Vocabulary – enables students to understand and continuously maintain a list of definitions and terms.
- Notes – for teacher and student communication.
- Wiki – enables the students to create web sites and extend them and change their content.

COURSE MATERIALS

Many sources were used for creating the learning module for Control System Fundamentals. The study materials were

worked out as a MS Word document. They were divided into weekly lessons and transferred into pdf format which are enabled for downloads from the e-learning site. The teaching text was then accompanied with animations, video sequences and pieces of programs, which can be distributed to students both the multimedia CD and the Moodle course.

The teaching text had to be completed with defined targets for each chapter in a form:

- “you will learn”
- “you will acquire”
- “you will be able to”

after finishing the chapter. These targets are formulated before students enter a chapter.

Special parts of the course create questions to each chapter. They can be:

- Testing questions, so a student finds out, if he or she went through the text concentrated on the targets and learnt them. Questions with either multiple or true/false answers are formulated. The multiple answers may have one or more options for a correct answer. The test is not limited and can be repeated as many times as the student needs to verify his/her knowledge.
- Final tests consisting of both theoretical questions and computed examples, for which an accuracy parameter can be set and which are time limited. The student has only one attempt here and results are included into student evaluation.

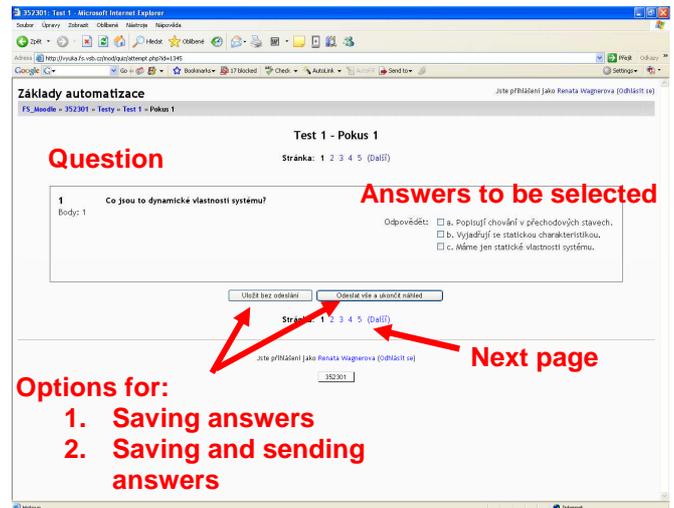


FIGURE 2
TESTING STUDENTS, QUESTIONS AND ANSWERS

The main advantages for testing students with the help of an e-learning module are:

- The questions are generated randomly
- The answers have a random order as well
- The environment offers an editor to insert questions and prepare the test
- The question can be accompanied by a figure (see Figure 3)
- More settings are available

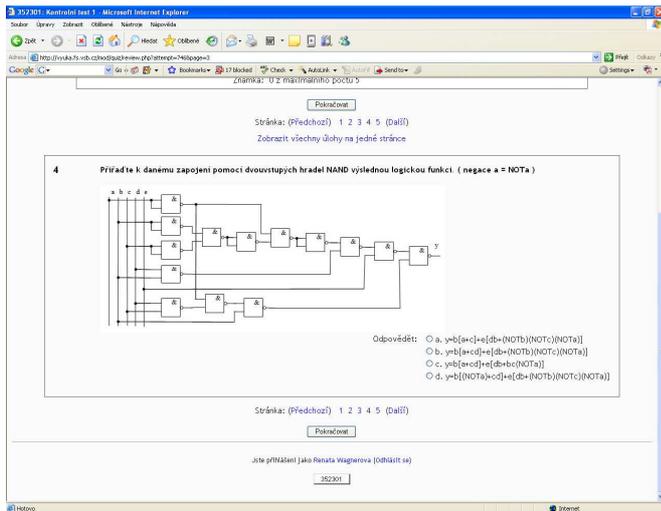


FIGURE 3
A QUESTION ACCOMPANIED WITH A FIGURE

The disadvantages may be considered as:

- The picture cannot be inserted by a student into an answer.
- There is no editor available for the answers, therefore more complex answers such as formulas cannot be entered.

The new learning module on a Moodle platform consists of the same teaching material and the same data as the multimedia CD, but it enables teacher – student communication and chat between students as well.

Twenty animations were created, explaining for example the principles of actuator functions, presenting control circuits, Watt controller, simulations of control systems for basic types of dynamic behavior: the simulation of a mathematical pendulum, a mass and a spring and a dumper system, Nyquist criterion of stability and others.

EXAMPLE OF ONE CONTROL TASK

One of the control system examples presented to students refer to the control of a required tank level value, described by a scheme, see Figure 4.

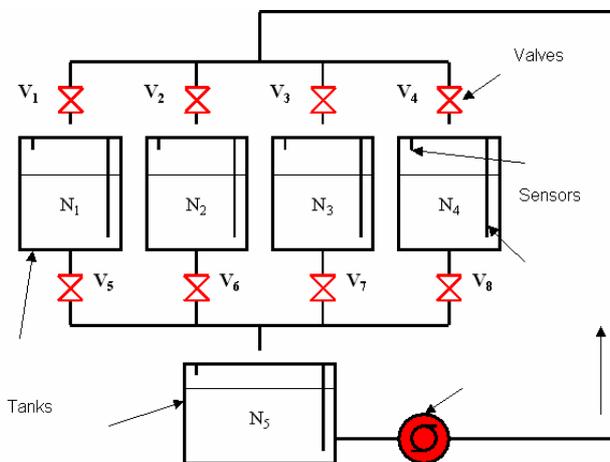


FIGURE 4
A SCHEME FOR A TANK LEVEL CONTROL TASKS

When the exercises take place in a lab, the students are working with the real time system, see Figure 5.



FIGURE 5
THE FRONT AND BACK OF A TANK LEVEL CONTROL MODEL

When the model is available online, as the visualization of the actual equipment, the task is presented as in the Figure 6.

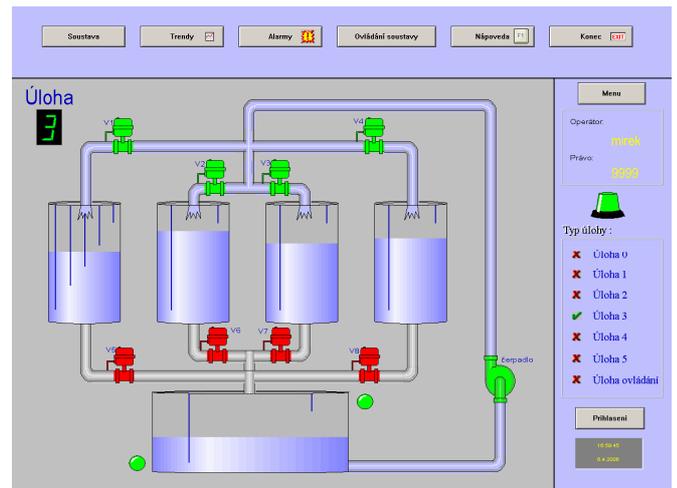


FIGURE 6
VISUALIZATION OF A TANK LEVEL CONTROL MODEL

With the visualization screens it is easier to understand the control systems algorithms and repeat the tasks done once in a lab later on.

Since the visualization programs introduce the possibility to monitor basic functions of supervisory control, such as alarms, trends and system security, the human – machine interface principles can be explained within the same application. Therefore the alarm limits were set on controlled values and alarm and trend displays were designed for visualized tasks (see Figure 7 and 8).

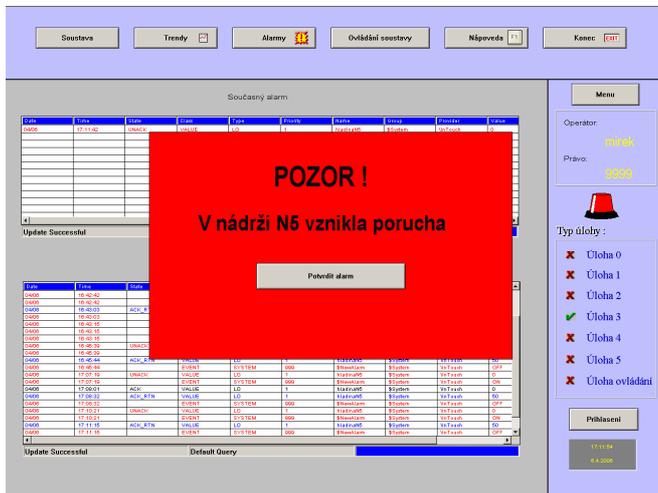


FIGURE 7

VISUALIZATION OF ALARMS FOR THE TANK LEVEL CONTROL MODEL

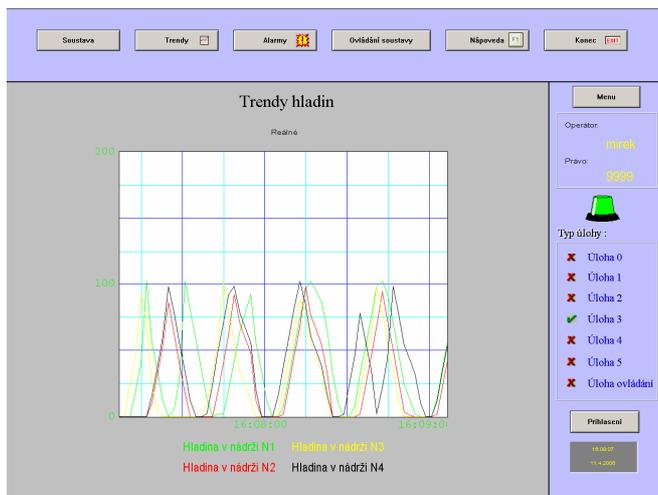


FIGURE 8

VISUALIZATION OF TRENDS FOR THE TANK LEVEL CONTROL MODEL

Modules in Matlab program environment were designed as well to display system behavior and controller characteristics with computed parameters.

CONCLUSION

Since VŠB-Technical University already exercises several Learning Management Systems, experience with using them challenges all teachers involved in the education process.

Past experience has shown how part time students find it difficult to combine their work load, family and the university study, therefore this project gives them the same opportunities and access to education as the full time students have. Furthermore, the modern e-learning forms of

study motivate all participating parties to increase their own ICT skills. Also, it needs to be mentioned that there is a continuous problem to make the study of technical fields more attractive due to its complexity, and this project increases the interest of youth in technical fields by introducing new approaches and the state-of-the-art technology.

The initial effort of teachers to prepare this teaching material is very time consuming, but brings benefits in decreasing the time for day to day preparations for lessons and exercises, and especially gives them a break from the routine work during examining and correcting tests of the students.

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